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12/7/09

Eddy Lin
TCEQ
Air Quality Planning Section
Austin, TX

Re: comments for reworking of 115 rules

Dear Eddy,

There are many problems with the current rules that are allowing floating roof storage tank degassing contractors to avoid actually degassing the tank, but none more pressing than the technique used to get the vapors out of the tank. A number of facilities and contractors are aware of the problem with air channeling and vapor stratification during degassing. This was clearly acknowledged by the woman from Tri-Star citing a degassing job where 4 different hose connections all around the tank were necessary to get all the product vapor out. A couple other tank terminals have also commented to us about the problems they have experienced with channeling.

The only way to get the vapor out of the tank through a single suction port is to mix the vapors and to push the undisturbed mass of VOC from the back and bottom of the tank around to the suction side fitting (see attached channeling document). Without proper mixing cargo vapors are not detected which leads to premature readings of low concentrations.

The 115 rule is designed to regulate when VOC in large tanks is allowed to be open-vented to atmosphere. When a facility gets readings of low concentration that meet environmental (and sometimes OSHA) requirements, the tank is open vented. If there is no mixing the test result will not be representative and these low concentrations will lead to premature opening of the tank. At this point a good deal of VOC is improperly vented to atmosphere. This can include chemicals like benzene that have been measured in inexplicably high levels at Houston's air testing stations on the east end of town.

Vapor mixing can be accomplished with any given vapor control device using a second blower skid. We priced out all the parts necessary with assembly and fittings and found that the whole unit will cost somewhere around \$10-15K. Compared to the cost of the control device which regularly exceeds \$200K, the blower skid will hardly affect the cost of the job. In addition a simple fitting will allow the mixing blower to be used on the same man-way that the control device is pulling from. The cost/benefit ratio shows there is no reason not to use this necessary equipment.

Degassing a tank from one suction point is almost physically impossible without proper mixing, says certified industrial hygienist Don Schaezler, Ph.D., P.E., CIH (see attached report). Without some mandated vapor mixing this loophole and technique will continue to cause tens of thousands of tons of VOC to be vented to atmosphere.

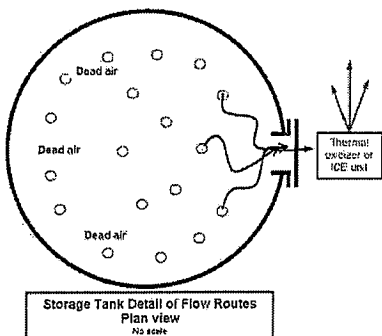
Regards,

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Channeling and tank degassing

Channeling is detrimental to effective vapor control. Channeling of the vapor inside of tanks during degassing is a much larger problem than degassing contractors give it credit for¹. Degassing is ineffective and time consuming if the vapors are not mixed or stirred.



Every combustion system pulls in outside air through the vents on the roof or the leg openings and around the roof seal. The replacement air continues on the path of least resistance to the exit port. The plan view diagram on the left shows channeling on a floating roof tank.

Replacement air can come from a number of open nozzles or from the perimeter seal or from openings around roof leg penetrations, gauge hatches and even the vacuum relief valve. This replacement air enters the tank at low flow rates and does not impinge on the mass of hydrocarbon vapors. Channeling leaves areas of vapor that are not circulated ('dead air'), not tested for at the combustion device and are not controlled.

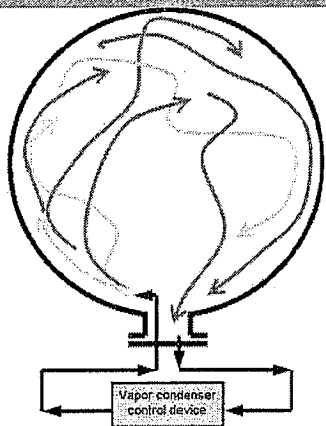
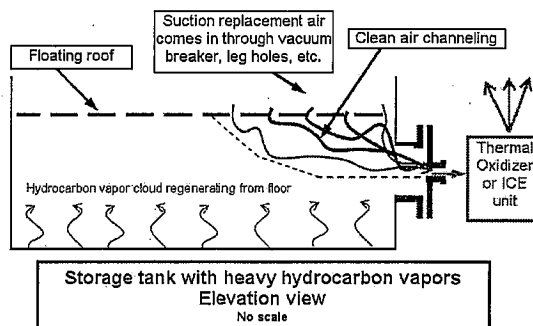
¹The American Conference of Governmental Industrial Hygienists in 'Industrial Ventilation' 21st Ed proposes that only a fraction of the dead air is picked up by the channeled vapors.

Heavy hydrocarbon clouds cause big problems. Hydrocarbon clouds are the result of cargo evaporation from the floor.

Hydrocarbon vapors are heavier than air and they lay on the floor of the tank like a cloud. This concentrated VOC cloud grows from the evaporation (or flashing) of cargo inside the tank.

When using a combustion device and pulling from one outlet, all the heavy vapors below the exit port remain largely undisturbed. The VOC is not drawn to the control device in a timely fashion.

In addition, concentration samples taken at the control device inlet are not representative of the over-all tank vapor.

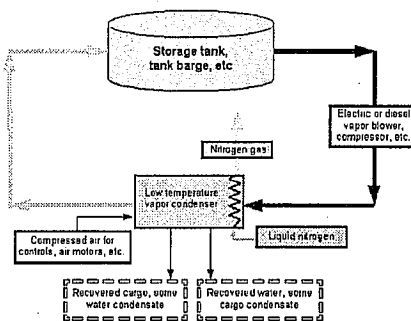


The PURGIT system solves the problem of channeling. PURGIT is the only degassing contractor in the country that operates with a return stream to the tank. This provides the 'stirring' of the vapor space that is necessary for a thorough job.

There are no dead areas in the vapor space and there is no channeling because of the mixing. Also, the extra movement inside the tank encourages the cargo to evaporate from the floor and that dramatically shortens the time it takes to degas the tank.

In addition, mixing provides an accurate cross section of the vapor when testing at the control device. Without proper mixing, it is not possible to get a representative sample of the tank vapor to determine whether state and facility specifications are met.

Another important benefit of our technique is the elimination of greenhouse gas production during tank degassing. The condenser system becomes an extension of the storage tank so no emissions are released during the vapor control. The condensate is collected and is returned to the customer for recycling, or PURGIT can handle the recovered condensate.



Controlling emissions from barges, rail cars, storage tanks since 1993.

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DEGASSING OF STORAGE TANKS

DISCUSSION OF LIMITATIONS OF TECHNOLOGIES

Donald J. Schaezler, Ph.D., P.E., CIH
ETC Information Services, LLC

INTRODUCTION

Degassing of large stationary storage tanks that contain volatile organic compounds is of great significance in industrial areas because of the potential for large emissions of the vapors in the tanks. The process has been regulated by TCEQ under 30 TAC Chapter 115 Subchapter F Division 3: Degassing or Cleaning of Stationary, Marine, or Transport Vessels. TCEQ is now considering comments relevant to these regulations. The purpose of this paper is to explore some of the limitations to the technologies being used in the degassing process.

LIMITATIONS OF TECHNOLOGIES

Limitations in tank degassing operations include the flow rate of the technology, the inherent limiting removal rate of the technology, and the mixing of the tank contents.

It is tempting to consider a storage tank being degassed as an ideally mixed Continuous Stirred Reactor (CSTR). However, the geometry of the tank volume, the layout of nozzles and vapor-relief valves, and the low velocities and energy generally applied to the tank contents make achievement of ideal mixing difficult. The parameters indicate that stratification of the contents and channelization of flow from vapor-relief valves to degassing nozzles will easily occur.

In addition to mixing limitations, each technology must be considered for its inherent processing limitation. For combustion devices, the limitation is the maximum heat release in the furnace. For condensers, the limitation is the maximum heat transfer capacity.

ILLUSTRATIVE EXAMPLES

The following example cases were used:

SUMMARY OF CASES CONSIDERED

Case Description

Cases with Ideal Mixing

- 1 Dilution ventilation at 1000 cfm
- 2 degassing limited by combustion at 2.4 million Btu/hr
- 3 degassing limited by condensation at 98,562 Btu/hr

Cases with Non-Ideal Mixing

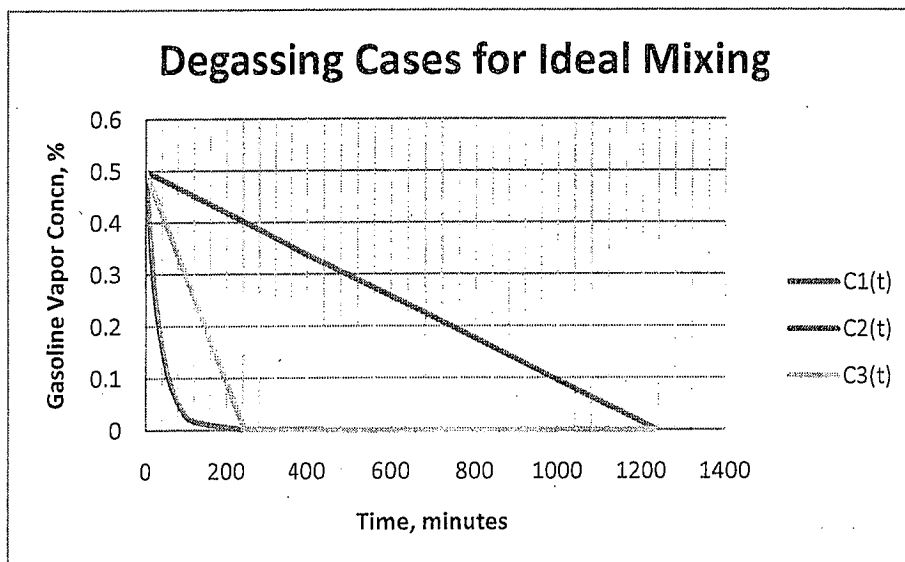
- 4 Dilution ventilation at 1000 cfm - Non-Ideal Mixing
- 5 degassing limited by combustion at 2.4 million Btu/hr - Non-Ideal Mixing

The results of simple models for each of these cases is shown below for a 100-ft diameter gasoline storage tank with the floating roof sitting 4.5-feet above the tank bottom and with the initial gasoline content in the vapor phase of 50%.

The models are simple and are not intended to be mechanistic. They are intended to be conceptual and preliminary and to illustrate basic concepts that apply to the real world. They do not include considerations of such factors as regeneration of vapors from residual liquid pools or liquid trapped in scale at the bottom of the tank. They also do not consider the detailed hydraulics of inlet and outlet flow regimes.

Ideal Mixing

These cases consider three examples with the assumption of ideal mixing in CSTRs.



Where:

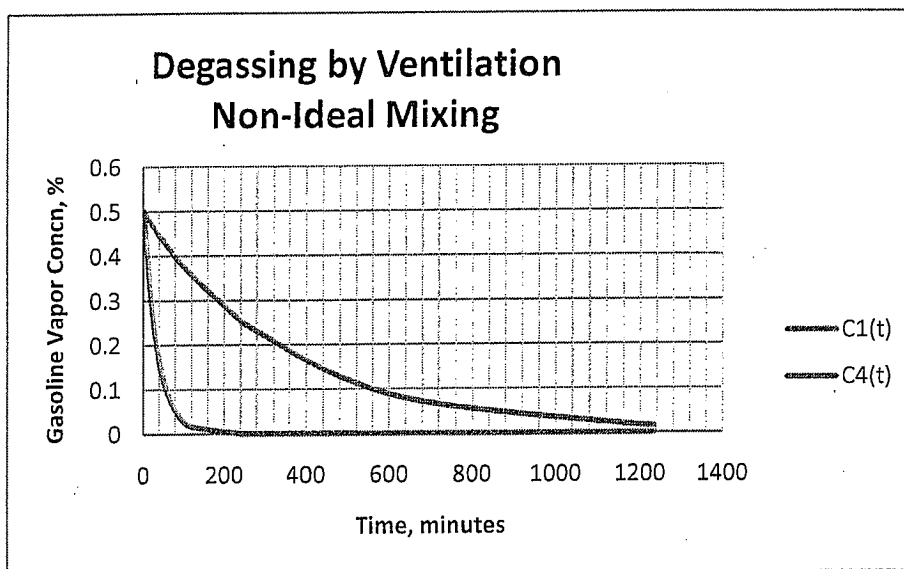
$C_1(t)$ is the concentration vs. time for Case 1, dilution ventilation at 1000 cfm

$C_2(t)$ is the concentration vs. time for Case 2, combustion at 2.4 MMBtu/hr

$C_3(t)$ is the concentration vs. time for Case 3, condensation at 98,562 Btu/hr.

Non-Ideal Mixing

Two example cases assume non-ideal mixing, first for simple dilution ventilation and then for the more complex case of degassing with destruction of gasoline vapors by combustion with distinct stratification and channeling of flow.

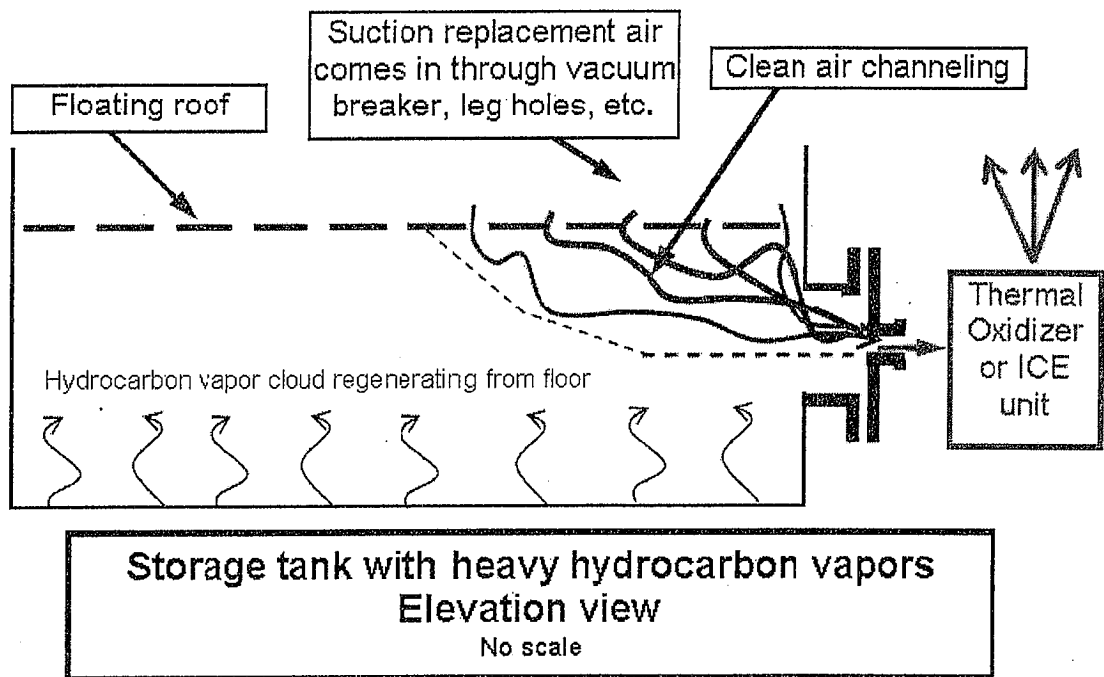


Where:

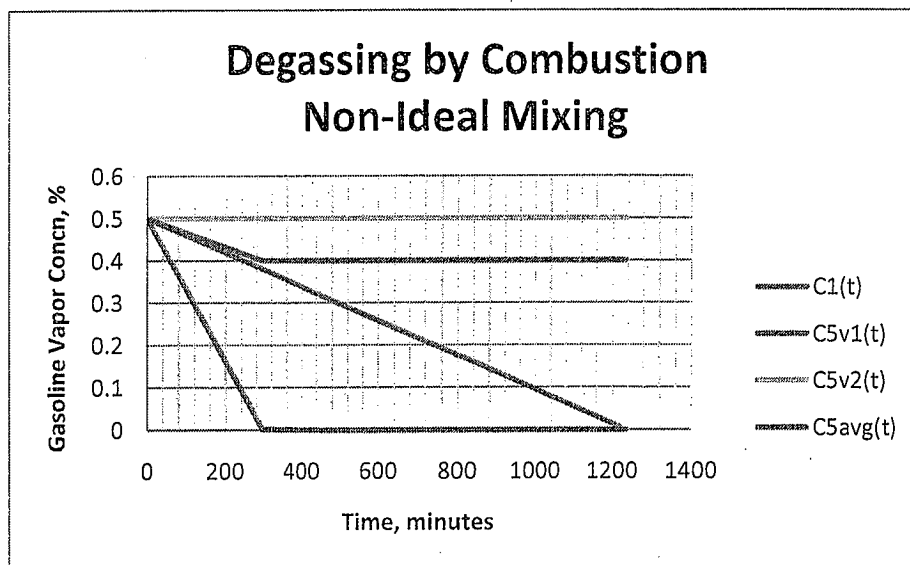
$C_1(t)$ is the concentration vs. time for Case 1, dilution ventilation at 1000 cfm

$C_4(t)$ is the concentration vs. time for Case 4, dilution ventilation at 1000 cfm but with non-ideal mixing in the tank.

In this case, C_4 refers to the average concentration in the tank, where stratification and channeled flow have created separate volumes with different concentrations, one relatively lean and one relatively rich. This concept is illustrated in a sketch prepared by Hilliard Emission Controls, reproduced below.



This concept draws upon stratification of air and channeling of inlet flow in air-conditioning distribution systems, as illustrated in *Industrial Ventilation*, 23rd edition, ACGIH, 1998 (see Figure 2-1, poor mixing case), and in several industrial hygiene references. In the case of ambient outdoor air entering a vapor space rich in gasoline, the stratification would be much stronger, almost as in two-phase flow systems.



Where:

$C2(t)$ is the concentration vs. time for Case 2, combustion at 2.4 MMBtu/hr

$C5v1(t)$ is the concentration vs. time for the stratified lean volume for Case 5

$C5v2(t)$ is the concentration vs. time for the stratified rich volume for Case 5

$C5avg(t)$ is the concentration vs. time for the volume-weighted average in the tank.

In this case, we considered a tank that develops stratification, with relatively lean vapor near the top and near the degassing nozzle, and relatively rich gasoline vapors near the bottom and in most of the tank. This Two-Volume Model assumed partial mixing, such as in the non-ideal mixing case, with vapor being drawn from the relatively lean vapor volume. Refer to the Hilliard Emission Controls sketch above.

The condenser alternative has a distinct advantage with respect to mixing, because most of the volumetric flow is returned to the tank at a rate, velocity pattern, and location conducive to tank mixing.

CONCLUSIONS & RECOMMENDATIONS

1. Limitations in tank degassing operations include the flow rate of the technology, the inherent limiting removal/destruction rate of the technology, and the mixing of the tank contents.
2. The limitations of the technology used for degassing must be recognized in application of that technology. The application must consider and be consistent with simple mass and energy balances.
3. The limitations of non-ideal mixing must also be recognized. If stratification and channeled flow occur, then the progress of degassing may be difficult to measure.
4. If degassing is terminated prematurely, because of mixing limitations and inaccurate vapor measurements, then the volume of contaminants ultimately flushed to the environment may be much greater than anticipated.
5. The State should consider these limitations, as illustrated in this paper. They may consider incorporation of requirements for mixing and testing that are consistent with the potential limitations discussed.